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Status of Development and Manufacture of Solid Oxide Fuel Cell at Topsoe Fuel Cell A/S and Risø/DTU

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Topsoe Fuel Cell (TOFC) provides the SOFC technology platform (cells, stacks, and integrated stack module – called PowerCore) for different market segments and collaborates with integrator partners to develop, test and demonstrate SOFC applications. The technology development is based on a R&D consortium with Risø National Laboratory (Risø/DTU) which includes material synthesis and cost effective ceramic manufacturing methods for anode and metal supported flat planar cells in addition to multilayer assembling for compact stacks with metallic interconnects.

The development is focussing on high electrochemical performance and durability as well as maximal robustness. Cells with new cathode compositions tested more than 7000 hours have shown significantly lower degradation rates with humidified air than the standard LSM based cathodes. Sc-doped zirconia has been introduced in the anodes resulting in much better tolerance to sulphur in H_2S containing methane, H_2 or syn-gas. Thin anode-supported cells have reached a very high mechanical strength of more than 400 MPa, whereas resent developed metal supported cells offer even further increased robustness.

The very compact TOFC multilayer stack concept with a power density of more than 2 kW per litre stack volume has been up-scaled to 18x18 cm^2 footprint and further optimized for easy manifolding and lower pressure drop with co- or counter-flow configuration . Standard TOFC stacks with a footprint of 18x18 cm^2 operate in the 3.2 kW power range. Larger stack footprints of 18x30 cm^2 are currently being constructed for test in 2009. Significant development activity is currently directed towards understanding and solving problems with cell and stack degradation and very promising results have been obtained making it possible to operate cells at higher current densities at very low voltage degradation. Test of stacks for more than 8000 hours with different selected stack components have revealed that not only the materials and stack components in question but also the fabrication processes have a significant impact on the performance and degradation rate. The first of a new lightweight high power dense stack has also been developed and tested in collaboration with UTRC.

Aiming at improved robustness and low material cost TOFC/Risø has increased the efforts towards development of next generation cells with metallic support (3G) including novel nano-structured electrodes and Sc doped zirconia electrolyte materials for operation in the temperature range 600-750 ^oC.

System designs using natural gas, LPG, methanol, DME, ethanol, diesel and ammonia have been studied and optimised. The studies and designs spans from the 1 kW micro CHP, through 5 -10 kW APU units and 250 -500 kW distributed generation plants to very large coal based hybrid plants.

TOFC is engaged in demonstration activities together with technology partners within the field of several of these promising segments. Test of PowerCore units integrating a stack with a nominal power of 3 kW with hot fuel processing units such as: Reformer, heat exchangers, catalytic burner, thermal management and instrumentation operating on diesel fuel is planned for 2009. A prototype Power Core designed for micro CHP application in the 1.4 kW range has been tested successfully as a part of the national Danish micro CHP program. A scaleable modular multi-stack concept is under development for large SOFC systems. A 10 kW prototype module is going to be tested in 2009. TOFC has collaborated with Wärtsilä since 2002 on development of SOFC systems for the 200+ kW market. Following the successful 20 kW alpha prototype at Wärtsilä containing 24 TOFC stacks, test of 20 and 50 kW systems with Wärtsilä are planed for 2009 and 2010 with natural gas, methanol and landfill gas.

In 2008 TOFC has constructed a 5 MW/year cell and stack production facility in Denmark featuring all the necessary unit operations from ceramic powders continuous tape casting, screen printing, spray painting and sintering to complete stack modules.

Reference

N. Christiansen, J.B. Hansen, H.H. Larsen, S. Linderoth, P.H. Larsen, P.V. Hendriksen and A. Hagen, Solid Oxide Fuel Cell Development at Topsoe Fuel Cell A/S and Risø, in ECS Proceedings Volume 7 No. 1, p. 31-39, (2007)